CEREAL SCIENCE *today*

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OCTOBER 1959 VOLUME 4 • NUMBER 8

OF INTEREST THIS MONTH

- GRAIN SORGHUMS
- WESTERN WHEAT QUALITY LABORATORY
- WHEAT PROTEIN

AN OFFICIAL PUBLICATION OF THE AMERICAN ASSOCIATION OF CEREAL CHEMISTS

THE NATIONAL

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Shown below in conjunction with
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PRICE — Sheeter only, Teflon Coated — $240

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EXPLANATION OF MOULDER:

Three hardwood rolls turn at 90 R. P. M. all in the same direction. The top roll is hinged, held up out of the way by spring tension for loading and unloading, yet instantaneously lowerable by operator to "mould" the sheeted and rolled dough. Stop pin of proper height assures of predetermined pressure, while extent of moulding is gauged by the number of revolutions of the roll. Black stripe on lower front roll is for convenience in counting the revolutions. Three revolutions could be said to be a "normal" moulding action. The moulded dough is then placed in the pan without further handling.

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NATIONAL MFG. COMPANY
LINCOLN, NEBRASKA

INSIDE SCIENCE

THE VITAL STORY OF

Breakfast Cereals

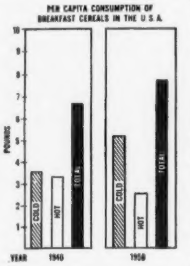
with essential vitamins and minerals restored

by Science Writer

New Edition

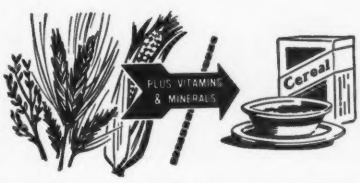
America Likes Breakfast Foods

The consumption of the dry type of cereals which are usually eaten cold has increased significantly. It shows a much higher rate of increase in recent years. For instance, in 1958 the per capita consumption of the cold type was 5.1 pounds as compared with 3.5 pounds in 1940. On the other hand, the hot type fell off from 3.2 pounds in 1940 to 2.5 pounds in 1958. Total consumption in this same period increased from 6.7 pounds in 1940 to 7.6 pounds in 1958.



Why are breakfast cereals so well-liked? They are tasty; they are easily served; they appeal to busy homemakers, as well as institutional dietitians, because they are readily available in a variety of flavors at a modest cost. They add interest and value to an important but sometimes neglected meal—breakfast. Their use is extending to between-meal and party snacks, too. Many grains are processed to make breakfast cereals: wheat, corn, oats, rice. Eaten with fruit and milk or light cream, they contribute an excellent combination of basic, flavorful, nutritious foods to the diet.

Better Foods for Better Health Through Restoration



The science of nutrition has advanced rapidly. In the manufacturing process of some cereals, some of the essential "B" vitamins and minerals are subject to some loss, just as with other foods. These losses are inescapable when such grains are prepared for human use. When this became known, manufacturers acted to overcome the losses. They adopted restoration.

Restoration simply means that certain important vitamins and minerals are restored to the cereal food during processing, so that the vitamin and mineral values in the finished product are generally equal to the whole grain values of those elements. Wheat, corn and rice products are customarily so treated. Vitamins B_1 (thiamine), B_2 (riboflavin), niacin (another "B" vitamin), and the mineral, iron, are those most widely restored. Vitamins C and D are also sometimes added.

Pre-sweetened cold cereals emphasize the nutritional importance of added vitamins. Increased calories require more "B" vitamins for best utilization of the food.

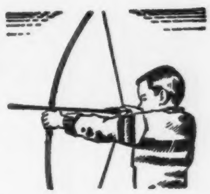
Why the Vitamins are Important

Physicians and diet experts have proved that vitamins are essential to prevent certain deficiency diseases and to contribute to robust good health.

Vitamin B_1 (thiamine) helps build and maintain physical and mental health. It is essential for normal appetite, intestinal activity, and sound nerves. A lack of this vitamin leads to beriberi, a rarity in the U. S. A., but still a very serious health problem in other parts of the world.

Vitamin B_2 (riboflavin) is essential for growth. It helps to keep body tissues healthy and to maintain proper function of the eyes.

Niacin is needed for healthy body tissues. Its use in the American diet has been largely responsible for the virtual disappearance of pellagra, a serious disease.



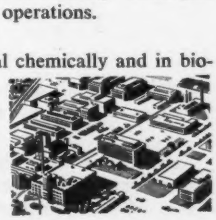
Vitamin D helps children develop normal teeth and bones. It prevents the development of certain abnormal bone conditions in adults.

Iron is essential for making good red blood and for the prevention of nutritional anemia.

Where Do the Vitamins Come From?

At about the same time that processing losses in breakfast cereals became known, other developments in the scientific world made available ample supplies of vitamins at economical prices. Thus, the nutritional contribution of some breakfast cereals could be, and was, greatly improved through restoration.

Since the early days of breakfast food restoration and of white flour and white bread enrichment, the world-famous firm of Hoffmann-La Roche has supplied top quality vitamins *by the tons.* Pioneering work in its laboratories and by its collaborators resulted in the "duplication" of some of nature's extremely complex substances. First, the chemical composition of the vitamin was learned. Second, the pure substance was isolated. Third, the "duplicate" was made by synthesis. And fourth, the laboratory techniques were extended to large scale commercial operations.



The manufactured "duplicate" is identical chemically and in biological activity with nature's own product. A vitamin is still a vitamin regardless of whether nature or man made it. So efficient is large-scale manufacturing, that vitamins are sold at a lower cost than if they were extracted from natural sources.

This article is one of a series devoted to the story of vitamin enriched or restored cereal products: white flour, white bread and rolls, corn meal and grits, macaroni products, white rice, breakfast cereals, farina. Reprints of this article, of any other in the series, or of all are available without charge. Please send your request to the Vitamin Division, Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada, Hoffmann-La Roche Ltd., 1956 Bourdon Street, St. Laurent, Montreal 9, P. Q.

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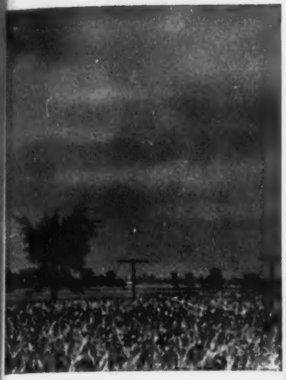

CEREAL SCIENCE *today*

FEATURES

TECHNICAL SECTION

DEPARTMENTS

STAFF

COVER: Photomicrograph of potato starch under polarized light. Courtesy of the U.S. Food & Drug Administration, Washington, D.C.

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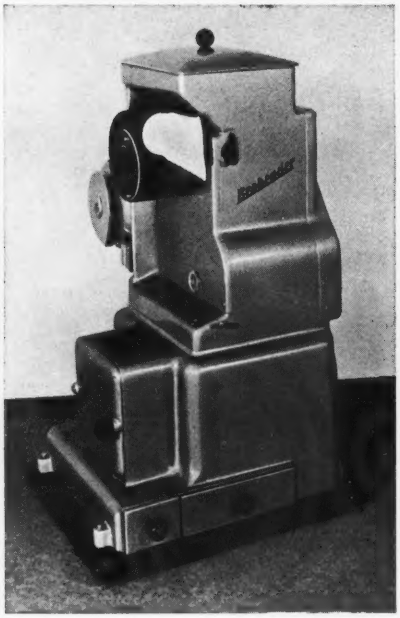

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Editorial

PLANT BREEDERS ARE important people. Through their efforts new wheat varieties are developed that possess disease resistance, ability to yield well, and good milling and baking qualities. These desirable attributes do not come about automatically. Plant breeders can check susceptibility to disease and yield potential in field trials. They must depend upon cereal chemists to ascertain the quality of their selections. Predicting the quality of wheat when only a small quantity is available for evaluation is a challenge that has been accepted by the cereal chemists working in the four regional wheat quality laboratories of the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture and co-operating experiment stations. The task is not easy, but the manner in which they carry it out makes these cereal chemists important contributors to the plant breeders' efforts to improve nature wherever possible.

Beginning in this issue of CEREAL SCIENCE TODAY, the organization and work of these four wheat quality laboratories will be described in a series of articles by the men responsible for their administration. Here are descriptions of the problems these laboratories seek to solve, the tools they have devised to get more and better information, and some of the objectives that lie ahead. Members of the AACC are acquainted with some of the research accomplishments that the staffs of these laboratories have published in CEREAL CHEMISTRY. Here is an opportunity to learn more about the philosophy that underlies the laboratories' programs.

All of us are financial supporters of government laboratories. The accomplishments of these laboratories are available to all who have an interest in them. Those who can aid their programs through sharing observations and ideas will benefit themselves and aid others by doing so.

We are happy to direct your attention to Dr. Barmore's article on the Western Wheat Quality Laboratory on page 235. Succeeding issues will carry articles on the other three laboratories.

P. E. RAMSTAD

THE PRESENT IMPORTANCE AND BRIGHT FUTURE OF Grain Sorghums

S. A. Watson, George M. Moffet Research Laboratories, Corn Products Co., Argo, Illinois

SORGHUM IS A crop of world-wide importance. To most Americans, perhaps, "sorghum" connotes a kind of syrup. Actually, the name applies to a whole group of plants in the grass family known by the scientific name *Sorghum vulgare*. The sorghum family has a history dating back to ancient civilizations in Africa and Asia. It now includes types that are major agricultural crops in many parts of the world, but all of the many varieties fall into four main groups: 1) the sweet or forage sorghums that have sweet, juicy stalks; 2) broom corn that produces the familiar long, fibrous seed stalks used in brooms; 3) Sudan grass, a fine-stemmed type that produces abundant forage; and 4) the grain sorghums that have thick, dry stalks and large, starchy seeds.

The grain sorghums — economically the most important type — are better known by such locally used names as "milo maize," "kafir corn," and "gyp corn" in the United States and "jowar" in India. They are grown in vast areas of the earth where rainfall is limited or uncertain, and will succeed there where corn and other cereals fail. The sorghum plant is perhaps more efficient than corn in absorbing and retaining moisture. It seems to have the ability to remain dormant during dry spells and grow again when watered (12).

The mature plant may grow to a height of 2 to 10 ft., depending on the variety, but most varieties now grown in the United States are about 4 ft. tall. The leaves and stalk resemble those of corn, but the grains are about the size of buckshot and are borne in clusters on a compact terminal head (see photo). Seed colors are characteristic for each variety, and include shades of brown, red, and tan as well as white.

Structure and Composition

The structure of the sorghum kernel is similar to that of corn (24), being composed of approximately 82% endosperm, 10% germ, and 8% bran. Chemical composition of sorghum grains is given in Table I.

Table I. Proximate Analysis of Grain Sorghums[a]

	Range % db	Average % db
Water (% wet basis)	8 –20	11
Starch	60–77	71
Protein (N × 6.25)	8–16	12.5
Fat (ether extract)	1.4 – 6.1	3.4
Ash	1.2 – 7.1	2.2
Fiber (crude)	0.4 –13.4	2.7
Pentosans	1.8 – 4.9	2.5
Nonreducing sugars (as sucrose)	1.0 – 1.4	1.2
Reducing sugars (as dextrose)	0.4 – 1.0	0.6
Tannin	0.03– 0.17	0.1
Wax	0.2 – 0.5	0.3

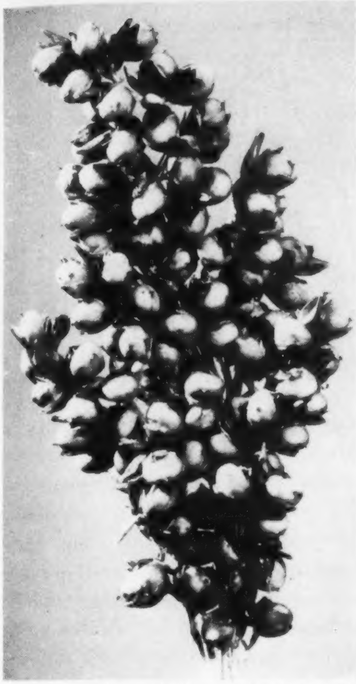
[a] Largely from references 19 and 29.

About 94% of the total starch of the kernel is in the endosperm, together with 81% of the protein; the germ contains 76% of the fat (9). Most varieties contain tannin and wax, but no carotenoid pigments (3,15). Recently a yellow variety containing carotene and xanthophyll pigments was discovered in Africa by O. J. Webster. Plant breeders are rapidly incorporating this yellow endosperm characteristic into standard sorghum varieties, but those produced to date contain only about one-fourth to one-half the pigment content of yellow corn (4).

A Valuable Feed Grain

Grain sorghum is used primarily as a feed grain in the United States. It is highly nutritious, and compared with corn its ability to produce weight gains is about 90% for beef cattle,

A field of grain sorghum grown for hybrid seed production near Plainview, Texas. Note alternating 6-row strips of pollen-shedding plants (dark rows) and male-sterile seed-bearing plants (light rows).



A single seed branch from a head of grain sorghum, about natural size. Each head is made up of 25 to 50 of these branches attached to the upper end of the central stalk.

95% for hogs, 98% for sheep, and 100% for poultry.[1] On the other hand, J. R. Couch has stated[2] that grain sorghum rations for poultry must be supplemented with 15% corn to get optimum growth and egg production. Its protein is about 78% digestible; the nitrogen-free extractive (NFE) is 91% digestible (20). Lyman and co-workers (16,17) have determined the essential amino acid content of six varieties of grain sorghum and of the by-product feeds from the wet-milling process. Miller (19) has tabulated all available data on amino acid content of sorghums. Using rats, Pond *et al.* (22) determined that the first limiting amino acid of grain sorghum was lysine and the second was threonine. From these data it is apparent that grain sorghum feeds must be supplemented with other protein sources such as soybean meal. Sorghum-based feeds must also be supplemented with additional calcium, phosphorus, and zinc, since grain sorghum is low in these minerals (19). The grain contains water-soluble vitamins at about the same level as in corn except for niacin and biotin, which are present in appreciably higher amounts (19,26).

[1] Ross, W. E. From a review, to be published as a bulletin by Kansas State Agricultural Experiment Station.

[2] Digest of Papers, Grain Sorghum Research and Utilization Conference, Amarillo, Texas, March, 1959.

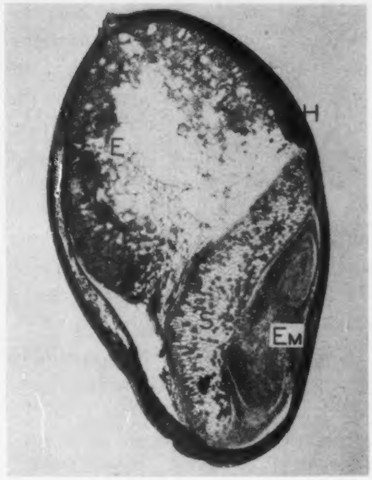
Grain Sorghum as a Food

People living in areas where more palatable grains are not available—such as in Africa, China, and Central India — use grain sorghum as a basic food. The grain is generally pounded into flour and eaten as a gruel, but it may be blended with wheat to make a kind of bread. Native beers are also made from sorghum varieties high in tannin(1). Sorghum malt contains predominantly the alpha-amylase or dextrinizing component of malt enzymes (14).

A variety known as "pop sorghum" has recently received publicity in the United States as a "noiseless popcorn." This variety can be popped to give expansion ratios of 20 or 25 to 1 (11). The small size of the popped kernel and its excellent flavor and thin hulls suggest its use in confections.

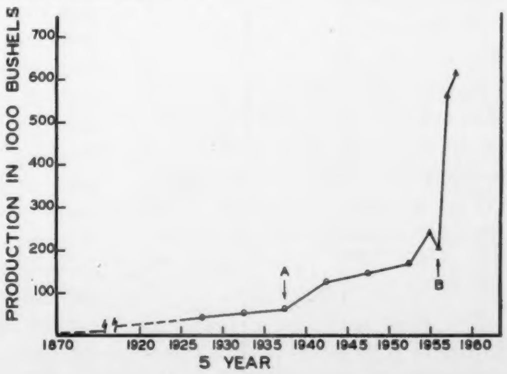
Production of Grain Sorghums and Development of Hybrids

Worldwide production statistics are inadequate, but estimated global production of grain sorghum was 950 million bushels in 1947 (1). It still ranks fourth in production behind wheat, corn, and rice, and is grown on all continents between the latitudes 45° North and South. Grain sorghum was first introduced into the United States about 1870 and has since gained steadily in popularity, as shown in the graph. Average production of 166 million bushels for the period 1947–1956 was grown on 8.38 million acres. During the last 2 years, production and acreage spurted to 564 million bushels (19.5 million acres) and 614 million bushels (16.8 million acres) for 1957 and 1958, respectively. The highest previous production was 242.5 million bushels in 1955. This greater yield has resulted from adequate rainfall in the sorghum areas and the continuing efforts of plant breeders. Hybrid sorghum types that gave acre yield increases of about 25% over previously established varieties were introduced in 1956. Since sorghum is a naturally cross-pollinated crop, commercial production of hybrids was made possible only by developing male-sterile types that could not be self-pollinated (23). Acceptance of hybrids by farmers has been rapid, and eventually all varieties will be displaced by adapted hybrids.



Longitudinal bisection, 10 microns thick, through a steeped grain sorghum kernel. H, hull; E, endosperm; S, scutellum; Em, embryo. The scutellum and embryo together make up the germ. The central portion of the endosperm has dropped out because of the softening effect of steeping. Magnification, 20×.

Average grain sorghum production in the United States for 5-year periods (circles) from 1925 to 1954 and for 1-year periods (triangles) from 1955 to 1958. A, combine varieties introduced; B, hybrids introduced.



Industrial Utilization

Processing. For most industrial uses the sorghum kernel must be processed to convert it to a more desirable form. For some uses, simple dehulling

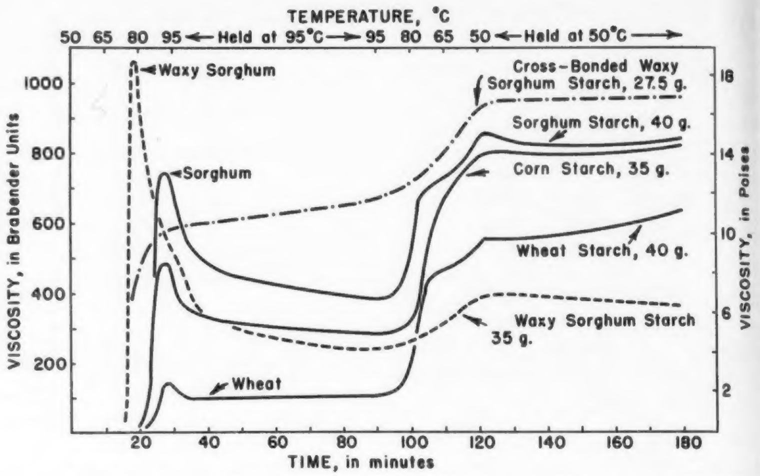
is all that may be required (28). Dehulling is generally done by abrasion which effectively removes most of the pigments and tannin located in the hull. The grain may be dry-milled to obtain an endosperm product similar to corn meal, but details of the process have not been published. A dry-milling pilot plant for grain sorghum at Dodge City, Kansas, has been producing grits, flour, and feed on a small scale for about 10 years (10).

The more exhaustive wet-milling process is required to produce purified starch, oil, and protein from the grain. A modern plant at Corpus Christi, Texas, was built in 1948 for wet-milling of grain sorghum by a procedure similar to that used for manufacture of corn starch (27). This plant has been milling about 20,000 bu. of grain a day to produce about 330,000 lb. of starch products, 330,000 lb. crystalline dextrose, 330,000 lb. of stock feed, and 20,000 lb. of edible oil each day. At present the plant is alternately processing two types of sorghum grain: the common red type for regular starch production, and a special white type for production of waxy starch products.

Properties of Sorghum Starch. Sorghum starch granules are round to polygonal in shape and are microscopically almost indistinguishable from corn starch granules (18). Range of granule diameter is 4 to 25 microns. Careful measurements of granule size distribution have shown that sorghum starch granules average 15.0 microns on a number basis or 17.4 microns on a weight basis; corresponding averages for corn starch granules are 9.2 and 14.1 microns, respectively (25). No differences in physical behavior between corn and sorghum starches have been related to the difference in granule size distribution.

Sorghum starch granules, both regular and waxy, gelatinize about 5°C. higher than corn starch granules, as measured by loss in birefringence (25). Average temperature range from start to completion of gelatinization is 67°–75°C. for sorghum and 62°–72°C. for corn starches.

The most important property of any starch is its ability to form a paste



Brabender viscosity curves for five different starches at indicated concentrations, g. dry starch/500ml.

upon cooking. Regular sorghum starch and waxy sorghum starch differ markedly in pasting characteristics, but each is similar to its corn counterpart (13,18). Changes in paste consistency on cooking and cooling are shown by the Brabender amylograms (13) in comparison with corn and wheat starches. Different varieties of regular sorghum and of waxy types possess essentially similar pasting characteristics (3,8).

Regular sorghum starch, which is marketed under the name "milo starch," produces a paste that is relatively stable to hot agitation. Upon cooling it sets up to a rigid, nonreversible gel. Like corn starch, milo starch contains about 27% amylose — the linear fraction that is responsible for gel formation and retrogradation.

Waxy sorghum starch is marketed under the name "white milo starch" because the grain from which it is made is white in contrast to the red grain presently used for manufacture of regular sorghum starch. Waxy sorghum starch paste has a very high peak viscosity, but hot agitation breaks it down to a lower viscosity level that is not recovered when the paste is cooled. Pastes, hot or cold, are clear, long, or stringy and stable on aging (13). The granules contain only amylopectin — the branched starch component. If the waxy starch is cross-bonded by a chemical treatment, such as with phosphate groups, the high viscosity peak may be depressed or eliminated, depending on the extent of treatment, as shown in the graph. This cross-bonding treatment also strengthens the granule against disintegration during hot agitation and gives a less stringy paste and a more stable viscosity, particularly in the presence of fruit acids (pH 3.5).

Food Uses of Sorghum Starches

Sorghum starches are particularly favored for use in bland foods because they have less "cereal flavor" than other cereal starches. The regular milo starch makes excellent puddings and is useful in custard pies, gravies, and similar foods (5). The blandness of these starches allows full expression of the natural flavors of the foods in which they are used.

The cross-linked waxy sorghum starches have the high stability required in many modern food products. The most popular use is in fruit pie fillings, where good consistency and appearance are required (6). However, they are also widely used to thicken such canned foods as Harvard beets, cream-style corn, salad dressings, soups, Chinese foods, and white sauces (5). Frozen pastes of the waxy sorghum starches are quickly and completely dispersible upon thawing and are relatively free from syneresis. These properties are most desirable for starch used in frozen foods and account for the successful application of the waxy sorghum starches in frozen pies and other prepared frozen foods (21).

Water-dispersible (pregelatinized) starches are produced by spray-dry-

ing pasted starch of regular and cross-bonded waxy sorghum starches. These products are useful in dry food items where instant thickening upon addition of liquids is desired, as for example in certain types of prepared dry mixes and instant puddings.

Important Industrial Uses

A requirement of textile sizes, to be quickly and completely removable from the woven fabric, is met by the waxy white milo starches. Their pastes produce films of high solubility but excellent sizing power, which makes for easier weaving, less thread breakage, and no "bridging over" due to gel lumps. The freedom from retrogradation gives longer usefulness to sizing baths. The thickening characteristics of waxy sorghum starches, combined with high paste stability, make them useful as thickeners in multiple-color printing of fabrics and paper.

Regular sorghum starch has industrial uses that are about the same as corn starch. It can be "derivatized" or acid-modified to any degree in order to fit properties required for a particular application. Industrial uses include adhesives and sizes in manufacture of paper and cardboard as well as for fabrication of miscellaneous articles from paper; refining bauxite ores; beneficiation of potash salts; binder in explosives; and many others.

Dextrin and Dextrose

Tapioca starch has long been famed for the quality of its dextrins, but now dextrins made from waxy sorghum starch match and even surpass tapioca dextrins. Pastes made from the waxy sorghum dextrins are clear and stable. Films have excellent clarity and flexibility and are instantly remoistenable. Among paper products which may be gummed with these dextrins are envelopes, stamps, and sealing tapes (7).

Crystalline dextrose hydrate is manufactured from grain sorghum starch by a process similar to that used for manufacture of dextrose from corn starch. Products are identical. Applications of dextrose extend through all areas of the food industry including manufacture of candy, bread, sweet baked goods, canned fruit, cured meat, and many others. Caramel color, useful in coloring foods and beverages, is now made from dextrose process liquors obtained from sorghum starch.

Oil and Feeds

Sorghum oil, amounting to 2.2 lb. per 100 lb. grain, is recovered from the germ isolated in the wet-milling process. Fatty acid components and physical properties of sorghum oil are almost the same as for corn oil (2). Refined grain sorghum oil is nutritious and tasty for salads and general cooking and is similar to corn oil.

The outer hull of the sorghum kernel has a relatively thick coating of wax that is easily extracted by immersing the kernels in hot solvent (15). This wax (m.p. 80°–84°C.) has characteristics similar to those of carnauba wax. Although it can be used in polish formulations, industrial applications have not been exploited.

Sorghum gluten, the protein of the endosperm, is used chiefly in animal feeds. The main protein component of sorghum gluten is kafirin, an alcohol-soluble protein with properties similar to those of zein from corn.[3] Sorghum gluten analyzes about 18% glutamic acid, making it a potential raw material for manufacture of monosodium glutamate.

The fibrous hull and germ residues are combined with gluten and steepwater — the soluble substances extracted during steeping — to make milo gluten feed (21% protein). This feed product is used as a protein concentrate in cattle and sheep rations.

A Bright Future

The grain sorghums have a permanent and important place in world economy. They nourish the populace of many arid regions, and furnish abundant animal feed for other areas of the world. In the United States, the future of grain sorghum is bright. It is a versatile, dependable crop, particularly suited for cultivation in the Great Plains states. New developments of the sorghum breeder will make tihs crop more widely adapted to drier as well as wetter areas of the country; will make possible new commercial applications; and will give it wider use in meat production to meet demands of an expanding population. Utilization of highly specialized products made by the dry- and wet-milling processes is in its infancy. It has been said that "corn's country cousin" has a potential which may surprise us all (11).

[3] Unger, G. F. Unpublished data.

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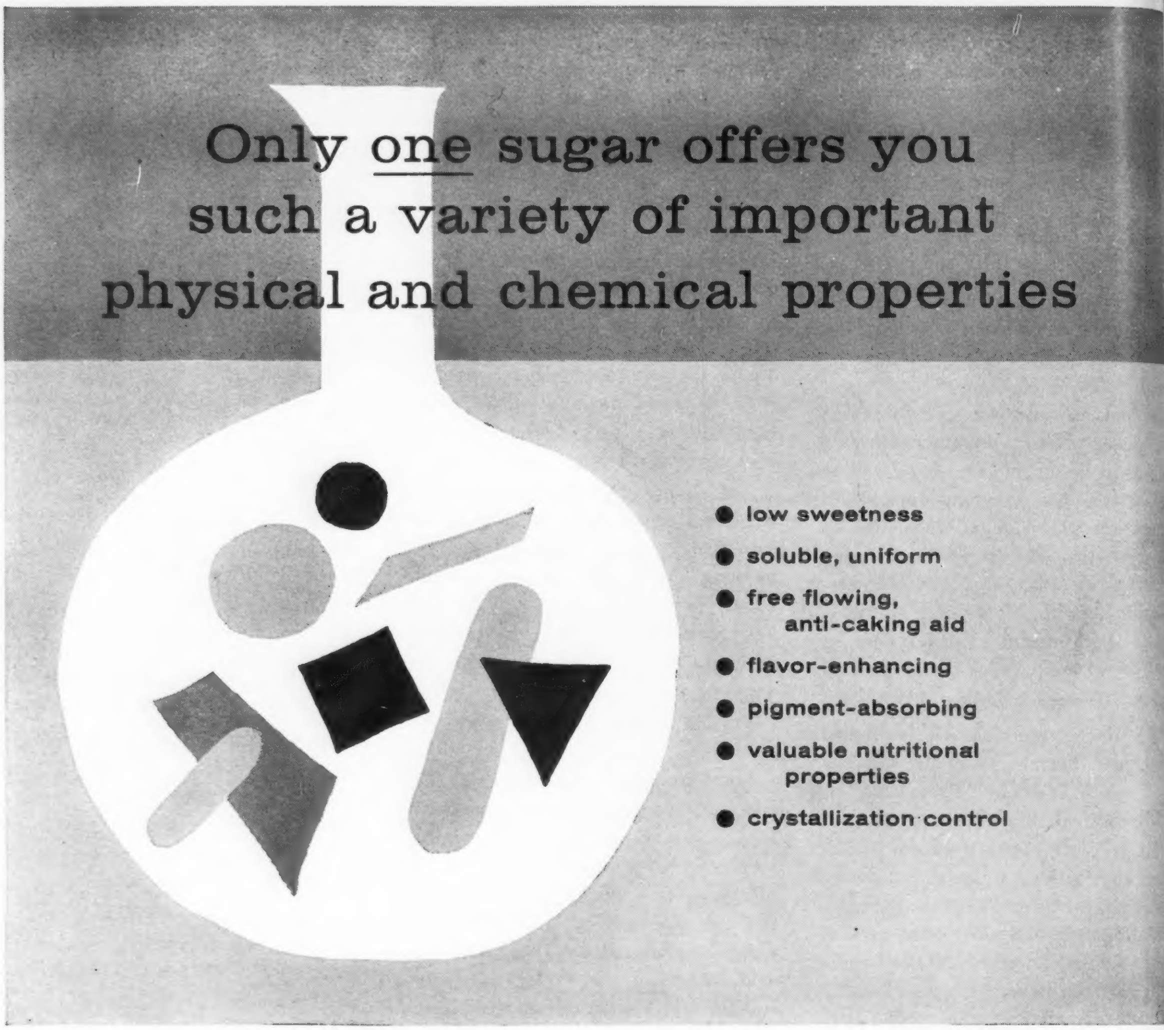
Only one sugar offers you such a variety of important physical and chemical properties
low sweetness
soluble, uniform
free flowing, anti-caking aid
flavor-enhancing
pigment-absorbing
valuable nutritional properties
crystallization control

HOW THE WHEAT IMPROVEMENT PROGRAM FUNCTIONS AT

The Western Wheat Quality Laboratory

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THE WESTERN WHEAT Quality Laboratory of the U.S. Department of Agriculture was established at Pullman, Washington, to aid the wheat improvement program in the Western states — mainly Idaho, Montana, Oregon, Utah, and Washington. Funds for the laboratory come from the U.S. Department of Agriculture and the Washington Agricultural Experiment Station. The laboratory was established in 1946 at Pullman as a part of the Department of Agricultural Chemistry of the Washington Agricultural Experiment Stations.

In the Western states, as in the other major wheat-producing areas, Federal and state plant breeders are developing new varieties to reduce or eliminate production hazards such as stinking smut, lodging, shattering, rust, foot-rot, and virus diseases. The primary purpose of this laboratory is to work with plant breeders to collect information on the processing characteristics of the new selections or hybrids being developed, as well as on those of commercial wheat varieties, and to do research on the development of new and improved methods of determining these characteristics. Such information is essential in deciding which new selections are the most suitable for final release and commercial production. Information of this nature, obtained early in the development of new varieties, permits the plant breeder to retain only the most likely selections and thus avoid further testing of unpromising material.

Types of Wheat Produced and Their Markets

The Western states have such a diversity of environmental conditions that they produce all classes of bread and pastry wheat — white winter club, soft white and hard white winter, hard red and soft red winter, soft white and hard white spring, and hard red spring varieties. All but a small fraction of the hard red spring wheat is produced in Montana. Almost no durum wheat is produced west of the Rocky Mountains. The protein level varies from as low as 6% to as high as 18%, depending on the environment. As a result of this wide diversity of types of wheat of varying protein content, all types of flour, with the possible exception of semolina, can be made from the wheat of the area.

The laboratory maintains a stock of several hundred wheat samples. All the varieties grown to any extent in this area are represented, usually at several different protein levels and from plots at several locations. This stock of wheat samples is one of the helpful features of this laboratory and is a great asset to the worker concerned with varietal differences.

The "strength" of these wheat types varies from that of the very weakest, low-protein white club varieties, through that of soft white and hard white, to that of the very strongest hard red winter and the high-protein hard red spring varieties. The wheats also vary in milling type from some of the poorest varieties to some of the very best in existence.

Much of the wheat produced in Montana moves east, out of the state. Most of the rest of the wheat produced in these Pacific Northwestern states moves west and is milled enroute or on the West Coast. Since the capacity of the mills of this area equals only about half of the westward-moving wheat, the remaining

Common types of wheat grown in the Western Region.

* The assistance of the laboratory staff in the preparation of this report is acknowledged.

half must be exported. Consequently, the area's market is about half domestic and half export.

Quality Evaluation by Conventional Methods

The work of the laboratory is divided into three main categories: 1) evaluation of the quality of new varieties by reliable and accepted methods; 2) improvement of accuracy of the quality tests, reduction in necessary sample size, and testing of new techniques; and 3) studies of the factors responsible for quality, and studies of the chemical and physical properties and the molecular characteristics of wheat flour constituents.

The evaluation tests need only brief mention, because standard procedures are used. The milling test is made on 2,400 g. of cleaned, tempered grain in a Buhler automatic mill with pneumatic elevators. The milling is done to obtain a maximum amount of flour of low ash content. The rate of milling, percentage of long patent (first and second break and first and second reduction flour), flour ash, and tempering moisture are recorded. This information is used to calculate the milling score, which weighs these factors according to their value to the miller. Only flour samples containing 10% or more protein are tested for bread-baking characteristics. Mixing characteristics are determined by observation during the preparation of the dough for baking and by means of the farinograph. Loaf volume is obtained by the straight-dough, rich-formula baking method with optimum mixing, optimum potassium bromate, and optimum absorption.

The flour samples containing less than 10% protein are tested for cookie baking characteristics, viscosity, absorption, and mixograph curve area at 60% absorption. These data are assembled, interpreted, and reported to the plant breeders.

Kernel hardness tests were made for several years, but owing to uncontrollable variations in technique and growing conditions they have been discontinued temporarily.

The degree of swelling of flour in dilute lactic acid (Zeleny sedimentation test) is determined for the bread flours, and the amount of water absorbed from a weak alkaline solution (01N $NaHCO_3$) is determined for pastry flours. These are relatively new tests which appear to have value in classifying the characteristics of wheat flour.

All data given to the plant breeders are reported as observed on a 14% moisture basis and on a corrected or adjusted protein basis (8% for pastry and 11% for bread flours), provided the correction is justified. The justification depends on the degree of significance of the correlation of protein content and the quality component for the variety. For new hybrids or selections a mean correction factor is used if the majority of varieties studied show significant correlation between the quality component and the protein content.

Plant breeders conferring with experimental baker relative to the quality of their new selections.

To give the plant breeder a concise summary of the quality of new selections in comparison with old, established, familiar varieties, all data are arranged on charts in the order of the mean quality component corrected to a protein level of 8 or 11%, or, if a correction is not justified, in the order of the arithmetic mean of each quality component. (See CEREAL SCIENCE TODAY, July, 1957, chart on p. 164.) Such charts make it easy to judge the acceptability of new selections.

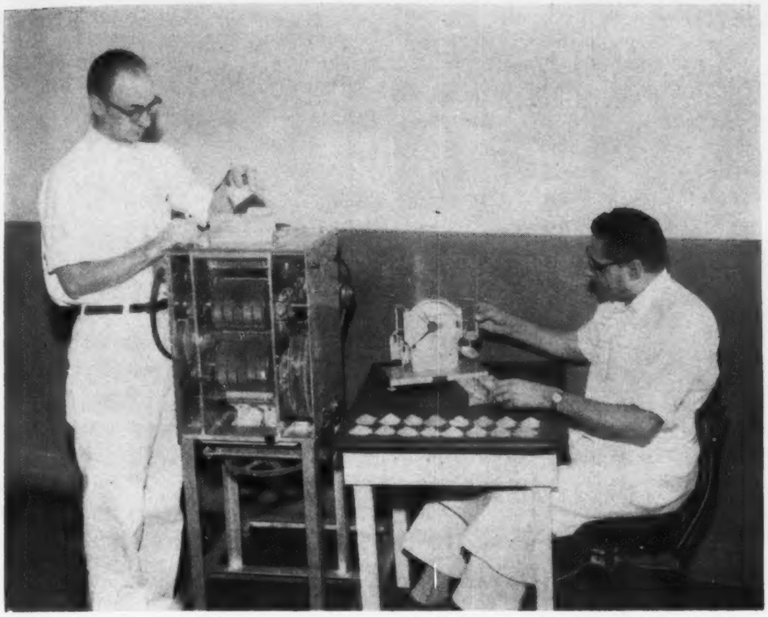
The plant breeders, in addition to breeding for improved agronomic characteristics, have been making crosses to improve milling characteristics of white wheats, and mixing characteristics of hard red winter wheats. Some of the most productive and disease-resistant white varieties have very poor milling characteristics; likewise, some of the most winter-hardy and disease-resistant hard red winter varieties have been poor mixing types.

White wheats have been the most important type in this area, but some varieties have deficient milling properties, and the determination of milling characteristics of new white selections has been emphasized. This has led to determination of the components of milling quality and their relative importance as expressed in the method of calculating milling score. This research has stimulated some very productive studies in other laboratories on pentosan content, kernel structure, and cell-wall thickness.

Quality Evaluation by Micro Methods

To increase the efficiency of their work, plant breeders have desired quality evaluations applicable to the grain from a single plant. This has led to the development of a 5-g. micromilling method and a micromill. About 100,000 selections have been screened for milling by this method in the last three years.

The success of the micromill, together with the importance of improved mixing characteristics and of the maintenance of other quality properties of current commercial varieties, has stimulated the development of preliminary tests to predict mixing time, loaf volume, absorption, and cookie diameter from the 2 or 3 g. of meal obtained from the micromill. These tests, using 0.4-g. samples of meal, have been successful and are



The micro mill and the resulting bran samples laid out for inspection.

now being applied to early-generation breeding lines to establish their usefulness.

Quality Research

Fractionation and reconstitution methods have been used to determine the constituents responsible for differences in the diameter of cookies obtained from flour from different varieties. The tailings starch and the water-soluble fraction were found to have the most effect on cookie diameter. The water-soluble material, on further fractionation, yielded a material relatively low in protein and high in pentosan content. This fraction had an extremely large effect on cookie diameter.

The same techniques were employed in a study of the chlorine bleaching of cake flours, since the process is a necessary treatment in cake flour quality evaluation of soft wheat varieties. It was found that most of the improvement from bleaching was due to the reaction with prime starch. The reaction with gluten had a smaller effect.

The investigations of molecular characteristics of flour constituents have indicated the following:

1. The linear starch content and the size and shape of the molecules in the gluten fractions of different varieties differ little.

2. The number of acid and basic groups on the protein molecules appeared to be the same for different varieties.

3. The high correlation of viscosity and protein content is due to the interaction of specific, soluble polysaccharides and protein.

4. The hard or high-viscosity varieties contain more of these polysaccharides, which are about 50% pentosan, than soft or low-viscosity varieties.

5. Polysaccharides from hard wheat have larger molecules than those from soft wheat.

6. Potassium bromate sensitizes and accelerates the polysaccharide-protein interaction.

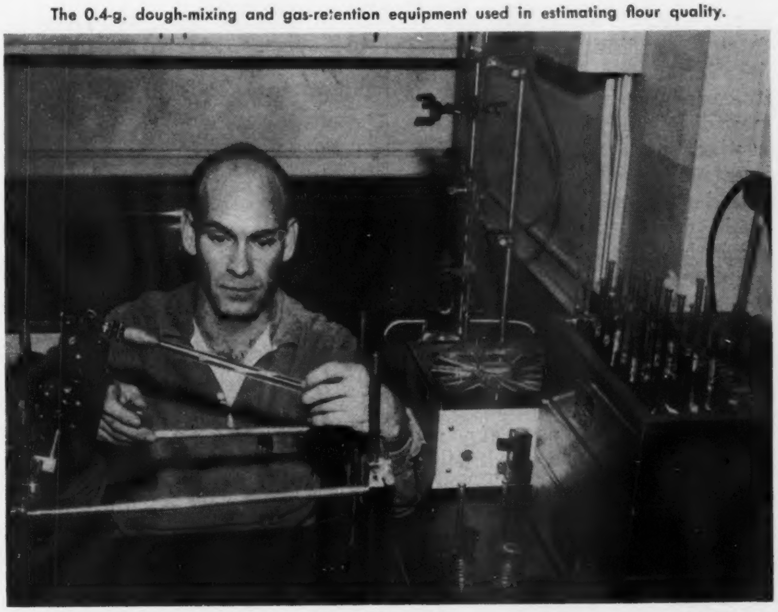
7. The constant amount of acidic dye bound by the basic groups on the protein molecule provides the basis for a new analytical method for determining the protein content of wheat, flour, milk, barley, and perhaps other materials.

Plans have been made for additional space and funds for laboratory impact grinding and air classification equipment. It is considered necessary to study the behavior of new varieties being considered for release, as well as currently grown varieties, by these methods. It is believed that our present experimental milling equipment is not adequate for cake flour evaluation of soft wheats. The study of flour of finer particle sizes than we have been able to obtain may result in more reliable cake flour evaluations.

Organized Interests in Wheat Improvement

The Pacific Northwest is especially fortunate in having a widespread organized interest in wheat improvement among breeders, growers, handlers, and processors. The older groups are the Oregon Wheat League and their Commission, the Pacific Northwest Grain Dealers' Association, the Association of Operative Millers, and the American Association of Cereal Chemists. The Washington and Idaho Associations of Wheat Growers, the Washington Wheat Commission, the Idaho Wheat Commission, and the Montana Quality Council have been formed more recently or have recently increased their effec-

The 0.4-g. dough-mixing and gas-retention equipment used in estimating flour quality.



tiveness. An advisory committee has been named to keep these organizations and the laboratory informed regarding new progress and needs for further research. This committee includes representatives of these organizations, as well as wheat breeders and agricultural experiment station workers.

Summary: Past Achievements and Current Problems

The laboratory has developed a micromilling method and equipment for preliminary tests of the grain from a single plant; a new method of determining protein in cereals and other agricultural products; and a punch-card system of compiling, comparing statistically, and summarizing quality data as aids in wheat improvement. Several new varieties have "run the gauntlet" of the testing program, have been released, and are in wide-scale production.

There are still many problems of vital concern to us. We are working on the chemistry of chlorine bleaching, the development of an improved cake-baking test, micro flour quality tests, and interaction of polysaccharides with protein. We would like to know more about the effects of fertilizers, especially nitrogen fertilizers, on wheat quality. Fertilizers may increase yield, or protein, or both, depending on time and amount of application and on soil and weather conditions. Increases in the protein content of soft wheats generally are not desirable. More should be known about the effects of irrigation on wheat quality. We should like to develop specifications for soft wheat flour in terms of determinable quality components so that we can have more definite targets at which to aim in wheat improvement. Since such a large proportion of Western wheat must be exported, more knowledge of the desires of the foreign trade should be obtained. There must be treatments, either physical or chemical, that improve the quality characteristics of wheat flour. The physiology and biochemistry of the developing wheat kernel, particularly the synthesis and deposition of the major constituents, protein and starch, must be determined. Mutation via irradiation or chemical treatments might possibly modify the structure of the wheat berry in such a way as to greatly improve its milling properties.

THE WEIGHT PER BUSHEL

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THE WEIGHT PER measured bushel, or more simply the weight per bushel, is a widely used practical index of the physical quality of grain. Superficially, this term appears to be self-explanatory. It is the weight of a specified volume of grain determined under defined conditions. For practical purposes this definition may be adequate and, on the basis of general experience, useful.

The weight per bushel represents a totality. From a more fundamental point of view, however, it is desirable to know what individual factors are included in this measurement. It is the aim of this paper to identify and to discuss some of these factors. Among the more significant factors selected for discussion are kernel size, packing, and density. The subject will be developed mainly from a consideration of first principles. No at.empt will be made to write a literature review.

Kernel Size

It is considered by many that kernel size may be one of the factors that determine the weight per bushel of a given kind of grain. The question arises whether it is the kernel size as such, or perhaps some other property associated with kernel size. One way of resolving this question is to consider a model system of spherical glass beads in a given volume.

Suppose we have a container 10 by 10 by 10 cm. Suppose further that we have two sizes of spherical glass beads, 1 cm. and 0.1 cm. in diameter. The large beads can be arranged in this container in columns 10 beads high and 10 columns along each side, making a total of 100 columns. The total number of large beads arranged in this way in the container will be 1,000.

The small beads can be arranged in the same way in columns 100 beads high, and 100 columns along each side. The total number of small beads in the container will be 1,000,000.

The next step is to consider the total volume of the large and of the small glass beads. The volume of each spherical bead can be readily calculated with the aid of standard formulas, and the total volume of the solid can be obtained for each of the two sizes of beads. Such a calculation shows that the total volume of 1,000 large beads is exactly equal to the total volume of 1,000,000 small beads. In other words, the total volume occupied by the solid in a container of a given size appears to be independent of the size of the spheres.

The implication of the above findings, with a model system, to a more basic understanding of the weight per bushel of grain is clear. The implication is that the kernel size of the grain, in itself, does not influence the weight per measured bushel.

Reference to *Principles of Field Crop Production* by Martin and Leonard provides further general support for the thesis that kernel size is not an important factor in determining the weight per bushel. Six different products that have a bushel weight of 60 lb. were selected. (Although bushel weight is a weight measure it is related to the average weight per bushel.) This group includes clover which has a count of 1,500 seeds per g., alfalfa with 500 seeds per g., common wheat with 20 to 24, soybeans 6 to 13, field beans 4 seeds per g., and finally potatoes which may weigh several hundred g. per tuber. In spite of a very wide divergence in size, these products are listed as having the same bushel weight.

Packing

In the discussion of the model system in the previous section, a specific system of packing was assumed for simplicity. With grain, a random type of packing would be expected and under uniform conditions it should be reasonably reproducible.

There are several factors that would be expected to influence the type and hence the density of packing, i.e., the weight per measured volume. Two of these factors are the shape of the kernel and the uniformity or heterogeneity in kernel size. For instance, random packing of round plump wheat kernels may conceivably give a different over-all bulk density from that given by random packing of long thin kernels. Similarly if small and large kernels of wheat were mixed together in the same sample, the density of packing may be different from that in the sample in which the kernels are of uniform size. The small kernels would, for instance, occupy interkernel spaces that were too small for kernels of regular size.

At the present time it is difficult to assess to what extent kernel shape and uniformity would be expected to influence the weight per bushel. Ideally, preliminary basic information may be obtained with suitable model systems. The reason for this is that grain is a somewhat complex system. For instance, a change in kernel size may involve a change in shape, and this in turn may be associated with a change in chemical composition, or in the biological structure of the kernel. However, with the main principles established with simpler model systems, it should then be possible to make considerable progress in studies with grain.

Density

In considering the weight of a measured volume of a granular material like grain two related aspects may be suggested. The first aspect, that of the density of packing of the material, has already been discussed. There remains

for discussion a complementary aspect, that of the density of the grain itself.

It should be obvious that, other things being equal, the higher the density of the grain kernels themselves, the higher will be the weight per bushel. Wheat, for instance, has compact, hard, and vitreous kernels of relatively high density. It also has a high weight per bushel. Oats, on the other hand, consist of material of lesser compactness and lower density. Accordingly, the weight per bushel is much lower.

The variation in density between different grains is, of course, much greater than the variation in density among the individual kernels within the same kind of grain. Nevertheless the variation in density within the same kind of grain may be quite sufficient to be reflected in the weight per bushel.

Among the factors that would be expected to influence the density of grain may be included the chemical composition and the biological structure of the grain. Kernels of grain that have matured under adverse conditions may not fill out normally and may therefore not achieve the vitreousness and density that would be obtained under more favorable conditions. The chemical composition may also be altered.

Another rather obvious factor influencing the density of grain is the moisture content. The density of dry wheat, for instance, is about 1.45 and that of water is 1 g. per cu. cm. Increasing the water content of the grain would decrease the density, and conversely. It is known, for example, that wheat of low moisture content is generally high in weight per bushel. However, a more precise assessment of the part played by those factors that influence the density of grain as components of the weight per bushel cannot be made at this time.

Thousand-Kernel Weight

At this stage it appears appropriate to examine the possible relation between thousand-kernel weight and the weight per bushel. Thousand-kernel weight simply measures the average weight of a kernel, with a factor of 1,000 included for the necessary precision of the determination. It thus includes two components, the size or volume of the kernel, and its density. Therefore, to the extent that the thousand-kernel weight reflects the size of the kernels, it would not be expected to be related to the weight per bushel. However, to the extent that it reflects the density of the grain it would be directly related to the weight per bushel.

Summary

The weight per measured bushel has been discussed in terms of individual component factors.

1. It is considered that the kernel size of the grain, in itself, does not influence the weight per bushel.

2. One of the factors that determine the weight per bushel is the density of packing of the grain. The shape of the kernels and uniformity or heterogeneity of kernel size may influence the density of packing.

3. The second factor that determines bushel weight is the density of the grain. This may be influenced by the biological structure of the grain and by the chemical composition, including the moisture content, of the grain.

4. Thousand-kernel weight includes two components, the average size of the kernels and the density. Only density is a factor in the weight per bushel. The correlation between the weight per bushel and thousand-kernel weight would therefore not be expected to be high.

FACTORS AFFECTING THE PROTEIN CONTENT OF WHEAT

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HOW MUCH PROTEIN will the wheat crop have this year? This is an oft-repeated preharvest question raised by numerous millers and bakers in the hard red wheat producing areas of the Great Plains. The importance of the question is associated with the well-established general relationship between protein content of the grain and bread-baking quality. While the correlation is by no means perfect, even today, armed as we are with the knowledge that protein *quality* plays an important role, *quantity* of protein remains the most important single criterion in the production of satisfactory bread. This relationship is particularly strong in dealing with the same variety; however, even here there exist numerous important exceptions. It is not surprising, then, that there is considerable interest in this subject.

Numerous investigators have studied the problem, and Salmon (16) stated that "probably there is no relation between climate and crops that has attracted more interest from investigators or has proved more confusing than that between climate and the protein content of grain." A study of the numerous reports dealing with this subject impresses one with the multiplicity of factors that play a role in protein content.

Generally the protein content tends to be high when wheat is grown in hot, dry climates, and low in moist, cool climates. According to Russell (15), the pertinent facts appear about as follows: In hot, dry regions, the nitrogen content of the soil and the rate of nitrification are in general higher, sometimes considerably higher, than in humid areas, and there is less leaching; hence the supply of available nitrogen in the soil at seeding time is

[1] Respectively, Professor and Assistant Professor of Agronomy.

greater. When moisture is limited, the plants make less vegetative growth and use less of the available nitrogen in producing leaves, stems, chaff, etc.; consequently, more nitrogen is left for the production of grain. When yields are lowered by drought, as is often the case, the nitrogen is distributed among fewer bushels. This statement emphasizes the well-known general negative correlation between protein content and yield of grain.

It has been concluded by Oswalt and Schlehuber (13), Shellenberger (19), and numerous other investigators that the major factors responsible for protein content and for bread quality, in order of importance, are 1) environment or climate, 2) soil, and 3) variety. While the relative value of each factor has not been determined precisely, Oswalt and Schlehuber (13) concluded, on the basis of the protein content of 13 varieties of hard red winter wheat grown at 12 different locations in Oklahoma in 1946–1947, that in this test the combined influence of climate and soil was over three times as effective as varieties in producing changes in protein content.

Reasonably Reliable Protein Estimates Can Be Made

Forecasting the absolute values of protein quantity in a given wheat crop is highly inaccurate with our present knowledge; however, usually reasonably reliable estimates can be made by well-informed people as to whether protein content will be high, average, or low in any given area. This is not to conclude, however, that such estimates as are made are adequate to satisfy the wheat trade. There seems little doubt that more reliable predictions of protein content in advance of the wheat harvest would benefit the entire marketing system.

One can rightfully ask the question: Does science possess sufficient knowledge concerning the various factors affecting protein content to control the amount? Stating it another way: By controlling the environment of the growing plant — such as moisture, temperature, length of growing season, etc., the fertility of the soil, and the genetics (variety) — is it possible to predict the protein content of the grain within rather narrow limits?

The early classic experiments of LeClerc and Leavitt (8) and LeClerc and Yoder (9) in their famous tri-locality or tri-state trials clearly demonstrated that climate played a much stronger role than soil in protein content of wheat. However, their studies failed to the extent that no data are presented on the relationship between protein content and grain yield.

As stated earlier, considerable evidence has accumulated to show that in general there is a striking negative correlation. Data pertaining to this relationship are presented by Oswalt and Schlehuber (14) and by Oswalt (12). In the latter publication, which is a continuation of the former, grain yields, percent protein content, and pounds of protein per acre are given for nine varieties of hard red winter wheat grown in 38 tests in Oklahoma in the period 1950–54. These results are summarized in Table I. The data show a more striking relationship between yield of grain and pounds of protein per acre than between yield of grain and percent protein.

The negative relationship between grain yield and protein content is usually stronger when one deals with the same variety. Eck (3) concluded that anything that is done with a given wheat variety to increase yields, short of adding nitrogen to the soil, will tend to decrease grain protein.

TABLE I

Grain Yields, Protein Content, and Amount of Protein for Nine Varieties Grown in Oklahoma in 1950–54

Variety	Yield and Rank		Protein and Rank		Protein per Acre, and Rank	
	bu		%		*lb*	
Concho	26.3	1	13.49	9	213	1
Westar	23.8	2	13.96	6	199	3
Wichita	23.7	3	13.79	7	196	5
Comanche	22.8	4	14.61	1	200	2
Triumph	22.7	5	14.44	3	197	4
Ponca	22.6	6	14.40	4	195	7
Pawnee	22.3	7	14.45	2	193	8
Cheyenne	21.6	8	13.74	8	180	9
Tenmarq	20.6	9	14.28	5	196	5

Experiments Show Influence of Varieties and Nitrogen

That genetic or varietal differences exist in ability to lay down various amounts of protein in the grain was shown by Oswalt and Schlehuber (13,14) and especially by Middleton, Bode, and Bayles (11). Two wheats, Atlas 50 and Atlas 66, not only produced significantly higher protein content than 11 other varieties of soft red winter wheat but also were among the highest grain producers.

At the Oklahoma Agricultural Experiment Station, Stillwater, in 1953, Atlas 50 and Atlas 66 produced 18.68 and 18.88% protein, respectively, and were about 2% higher than six other varieties in the test. Atlas 50 produced 296 lb. of protein per acre and ranked first; Atlas 66 produced 276 lb. and ranked third in the test. Another experiment related to this subject was carried out by McNeal *et al.* (10) in Montana with eight varieties of spring wheat. Although the main objective of the study in Montana was to determine the influence of barley stripe mosaic on yield and other plant characters, grain yields and protein contents are reported for four nitrogen levels (0, 25, 50, and 100 lb. per acre) for healthy and diseased plots. A striking negative linear relationship exists between protein content and yield and between protein content and pounds of protein per acre, but there is an even stronger positive linear relationship between grain yield per acre and pounds of protein per acre.

The Montana studies, as well as many others, showed the marked effect of protein content and the amount of available nitrogen in the soil in both the healthy and diseased plants. The grand average pounds of protein per acre for all fertilizer treatments and all eight varieties was 340 for healthy wheat, compared to only 242 for the diseased wheat (calculated from data in Table 2, McNeal *et al.*, 10).

Nitrogen Has Greater Influence on Protein Than on Grain Yields

A more detailed study of the relationship between protein content of the grain and grain yield as influenced by available nitrogen was made at ten locations in western Oklahoma in 1958. These results are summarized in Table

II. The data indicate a more striking relationship between amounts of added nitrogen and percent protein than between added nitrogen and wheat yield. In this study there was as much difference in protein content between locations as there was due to nitrogen additions at the specific locations. Even though soil application of nitrogen substantially increased protein percentage of the grain on most soils, extremely high protein compositions were not obtained even with heavy nitrogen fertilization.

TABLE II

GRAIN YIELDS, PROTEIN CONTENT, AND AMOUNT OF PROTEIN DUE TO NITROGEN FERTILIZATION IN WESTERN OKLAHOMA IN 1958

SOIL	RATE OF NITROGEN	YIELD	PROTEIN	PROTEIN
	lb/A	*bu/A*	%	*lb/A*
Hollister Clay Loam	0	39.5	11.7	277
	40	43.1	11.5	297
	80	36.4	13.0	284
	160	32.9	14.2	280
Pond Creek Silt Loam	0	32.1	13.9	268
	20	35.4	13.9	295
	40	35.8	14.4	309
	80	34.9	15.2	318
	160	32.7	16.3	320
Carey Silt Loam	0	31.1	8.6	160
	40	37.7	9.4	213
	80	40.3	11.5	278
Tillman Silt Loam	0	34.6	9.1	189
	20	34.7	9.2	213
	40	40.4	10.5	255
	80	40.7	12.1	293
	160	35.4	12.7	270
Tipton Fine Sandy Loam	0	20.4	12.5	153
	40	23.5	11.9	168
	80	24.4	11.6	170
	160	22.3	11.5	154
Bethany Silt Loam	0	26.9	8.7	140
	20	30.9	8.8	163
	40	33.7	9.2	186
	80	35.5	10.5	224
	160	29.6	11.3	201
Minco Silt Loam	0	45.9	9.9	273
	40	46.9	10.2	287
	80	44.5	11.0	294
Spur Sandy Clay Loam	0	27.9	9.3	156
	40	38.8	9.5	221
	80	40.5	9.9	241
	160	36.8	12.4	274
Foard Clay Loam	0	25.3	11.0	167
	20	24.8	11.3	168
	40	25.5	11.5	176
	80	24.6	12.4	183
	160	20.3	13.4	163

Finney *et al.* (4), using urea solutions as a foliar spray on Pawnee wheat, were able to obtain fairly high protein contents along with high yields. In these studies, which involved 33 treatments at each of three concentrations (equivalent to 10, 30, and 50 lb. nitrogen per acre) along with five controls, there were 312 plots. Foliar applications per treatment were 1, 3, 5, 7, or 15, and were made from 49 days before flowering to 35 days after (ripe). The average protein content of the control plots was 10.8%, and grain yield averaged 29 bu. Highest protein content (21.0%) was produced with 15 sprayings at the 50-lb. nitrogen level. It seems significant that the grain yield from this treatment (only 22.4 bu. per acre) was the only one that was significantly *less* than the control. Their data show numerous striking increases in crude protein content by single sprayings with urea. A single spraying at the time of flowering increased protein content by 0.8, 2.5, and 4.4% for the 10-, 30-, and 50-lb. nitrogen rates, respectively. A majority of the significant increases in yield, however, were obtained from urea treatment before flowering.

Discussion

The effect of environment on protein content of wheat has been the object of numerous studies. Most investigators are agreed that climate exhibits greater influence on protein content of wheat grain than any other one factor of environment (1,5,6,7,17,18,20,21). Soil fertility, especially available nitrogen, has also been shown to have a marked effect. The work of Middleton *et al.* (11) showed that certain varieties have a much more pronounced effect than was formerly thought.

At this point it seems logical to return to a question posed earlier: By controlling the environment, the fertility of the soil, and the variety, is it possible to predict the protein content of the grain within rather narrow limits? The authors are not aware of any reports stating that this had been accomplished. Clements, Shigeura, and Akamine (2) were able to rather accurately predict total sugar production by sugar cane in the Hawaiian Islands by a detailed study of morphology, physiology, and climate and the use of a series of rather complicated equations. It would appear that by thorough detailed studies in the field of protein content similar relationships could be established, as was found by Clements *et al.* (2). Inasmuch as many factors of the environment cannot be controlled in nature, a thorough study under controlled conditions (growth chambers) would yield valuable information. Even with our present knowledge, under carefully controlled conditions of plant growth including moisture supply, temperature, available nitrogen, and variety it is possible to predict protein content of the grain within rather wide limits.

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People, Products, Patter

• • • People

Leonard F. Barrington named director of applications research for A. E. Staley Mfg.; succeeds **James P. Casey,** now with Union Starch & Refining.

Roy K. Durham, in South America on a consulting assignment, had as luncheon companions recently **Eusebio Garcia, Octavio Oltra,** and **Hector Wulf,** at Hotel Carrera, Santiago de Chile. Ing. Garcia is director of the School of Baking, Instituto Nacional de Comercio, Santiago; he has studied at the American Institute of Baking, Chicago. Ing. Oltra is laboratory chief of the Chilean institute. Ing. Wulf is head of the Laboratory for Milling and Baking, Ministerio de Agricultura, Santiago; he spent some time at Agricultural Research Center, Beltsville, as a Rockefeller Foundation fellow. These Chilean cereal chemists, who are readers of **This Journal** and of **Cereal Chemistry,** wish to be remembered to their friends in the United States.

Paul S. Gerot, president of The Pillsbury Co., elected to board of directors, Minneapolis-Honeywell Regulator Co.

Wolfgang Kempf of the Starch Division, Federal Cereal Research Laboratory, Detmold, Germany, has just completed three months of work with **R. M. Sandstedt,** Department of Biochemistry and Nutrition, College of Agriculture, Lincoln, Nebraska. **Bennett D. Hites** continues work with Dr. Sandstedt.

Robert Larsen, manager of central research for The Pillsbury Co., is making a scientific European tour; he attended a symposium of the International Society for Fat Research at Graz, Austria, and a week-long session of the All-Union Institute for Cereal Research, in Moscow. Other visits were to the University of Uppsala, Sweden; and to Stockholm for meetings of the Royal Institute of Technology. He returns to the U. S. in mid-October.

Paul Mattern now in charge of the new Wheat Control Laboratory, which is being initially financed by the Nebraska Wheat Commission.

Melvin L. Ott named research lab manager at Durkee Famous Foods, Chicago.

William H. Pinchin elected president of Pillsbury Canada Ltd., as a step in the company's policy to establish an all-Canadian management. Mr. Pinchin has been executive vp since 1956; was formerly manager of PCL plant in Calgary.

William B. Reynolds named vp in charge of research, General Mills; will be responsible for the coordination of research conducted by the Central Research Laboratories as well as the divisions, and integration of such work in the total research program of GM.

Dorr E. Tippens, process engineer at American Sugar Refining, becomes head of new food products development for the company, Brooklyn.

• • • Patter

Florasynth offers latest flavor/aroma catalog. Flavors, spices, certified colors, sauce bases, aromatic chemicals, and cover odors are listed in great variety in the latest comprehensive Florasynth catalog, many of them according to application. Various formulas for the proper use of these products are included. Copies of the 36-page book can be obtained by writing on your company letterhead to: Florasynth Laboratories, Inc., 900 Van Nest Ave., New York 62, N. Y.

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Bausch & Lomb safety products for industrial and laboratory job requirements are listed in a new 40-page catalog describing plastic, metal, and combination safety glasses, specially designed goggles and eye shields; and giving complete specifications for Bal-SAFE lenses and the new Enduron plastic lenses. There is information on B&L vision-testing instruments, the new "Quiet Ear" protector, and a line of safety eyewear cases. Each item is illustrated by product and "in-use"-type photos. An indexed price list simplifies ordering.

For catalog A-1762 write to Safety Products Dept., Bausch & Lomb Optical Co., Rochester 2, N. Y.

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Bausch & Lomb's Honorary Science Award Program is the subject of a recent case study prepared by the weekly news letter for executives, PUBLIC RELATIONS NEWS. Citing the present need for American business to contribute aid to educational institutions which are training young men and women for careers in science, PR NEWS describes the B&L system of providing annual awards for science students in several thousand secondary schools throughout the U. S.

AACC

LOCAL SECTIONS

Nebraska Section held its annual picnic on August 16 in City Park, Seward, Nebraska. Highlight of the event was the announcement that Robert Pruckler of Nebraska Consolidated Mills, Grand Island, has been awarded, for the third successive year, the Shafer Trophy for the best check sample analysis; this means that the trophy is his "for keeps."

Next meeting is the Tri-Section meeting in Manhattan, Kansas, in October.

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Pacific Northwest Section's accuracy awards for 1958-59 were given to Walt Broom, for Moisture, and Harris Butler, for Ash and Protein. The over-all accuracy award was tied and two certificates therefore were given; one to J. W. Woodahl and the other to H. R. Fisher.

Committee chairman appointments recently made are: Fred Barrett, membership; Dick Fuhr, special awards; Martin Wise, commercial scale milling and baking; B. Lynn Speaker, crop survey; E. P. Walker, PNW grain storage sanitation. Representatives appointed are Otho Skaer, to the Agronomy Advisory Board; William L. Haley and Don Colpitts, to the PNW Crop Improvement Association; and Don Sundberg to the Western Wheat Quality Laboratory.

Martin Wise and Don Colpitts were recent visitors to the Washington State University campus for the annual Field Day program.

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New York Section's first meeting of the season was held on September 8, a dinner meeting at the Brass Rail Restaurant. The timely subject, "Glucono-delta-lactone in baked products," was covered by Charles Feldberg of Chas. Pfizer & Co.'s technical service department; he discussed the use of GDL in instant bread, cake, and all-purpose mixes.

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Niagara Frontier Section met September 19, with families and friends, for a day of observation and enjoyment at the New York State Agricultural Experiment Station, Geneva. The schedule included a look at the new Science Building (not completed), lunch at the Indian Mound Restaurant, and inspection of the fruit show of the State Fruit Testing Association. The main event was a trip through the Station, covering feed inspection including microscopy, residue research, and biological vs. chemical control of insect pests. Flower seed trials in the Seed Department, and work with dwarf fruit trees at the Rootstock Farm were also open for inspection.

For its very enjoyable annual picnic, the Section wishes to thank the Collins family and the following financial contributors: Wallace & Tiernan, Inc.; Will-Buffalo Corp.; Macalaster-Bicknell Co.; Hoffmann-La Roche, Inc.; Feedstuff Laboratories; Merck & Co., Inc.; Sterwin Chemicals, Inc.; Chas. Pfizer & Co., Inc.; and Fisher Scientific.

Midwest Section's first monthly meeting of the season will be held on October 5. Guest speaker D. B. Pratt, Jr., will discuss AACC affairs and present a technical paper on "New developments in flour-milling technology."

Meetings are held the first Monday of every month, October through March, at the Builders Club, 228 N. LaSalle St., Chicago. Social hour at 5:30 p.m.; dinner served at 6:30 p.m.

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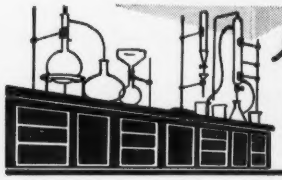
Lone Star Section met jointly on September 18 and 19 with members of Texhoma District 7 AOM, at Lake Texhoma Lodge, Kingston, Oklahoma. The program on Saturday morning included a presentation on self-rising flours by Glenn Fite of Victor Chemical Works; introductions and comments from national AOM officers present; and a movie, "New milling equipment" presented by the Buhler Mill Engineering Co.

In the afternoon President D. B. Pratt, Jr., gave an address; Ruben Kachikian of Chas. Pfizer & Co., Inc., spoke on "New horizons in the food and baking industry." A movie was shown, "Our daily bread," courtesy of Mrs. Baird's Bakeries, Inc., of Dallas.



laboratory HELPS and GADGETS

LOW-PRESSURE AIR SYSTEM

Bob Kilborn uses an interesting variation of the low-pressure air system described in CST March 1959 pp. 82-83. For the compressed air reservoir he uses a section of automobile inner tube, sealed at each end, and containing two valve stems, one with the core removed. Air supply is from an electric pressure pump and enters the reservoir via the valve stem containing the core and is drawn off through the coreless stem.

A board, hinged at the lower end, is laid over the inner tube so that as the tube is inflated the free end of the board will rise, thus altering its angle to the horizontal. Mounted on this board is a U tube containing a small amount of mercury and with copper wires making contact with the surface of the mercury when the board is level and until it reaches a predetermined angle. These wires are connected in series with the power supply to the pump. As the tube is inflated the U tube is tipped until contact is broken and the pump stops. When it deflates, contact is re-established, so that constant pressure is maintained.

Pressure can be adjusted by 1) altering the amount of mercury in the tube, 2) altering the angle of the arms of the tube with the board, 3) altering the length of the wires entering the tube, placing a weight on the end of the board, or 4) altering the width of the board.

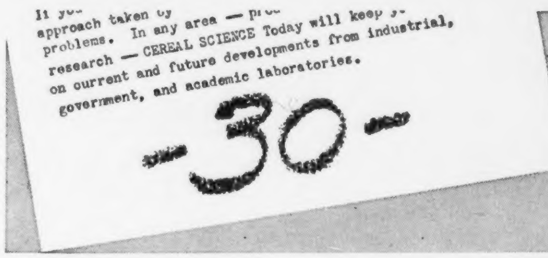
If a mercury manometer is placed in the pressure line, electrical contact could be made and broken through it instead of through the U tube.

This system has some points of advantage over the system described earlier:

1. It is completely automatic.

2. The bottle reservoir described earlier must be placed on or above the work-bench so that water accumulated in it can be siphoned off into the sink. The reservoir described here can be placed in any convenient location, such as in a closet under the work-bench, so that it will be out of sight and out of the way.

Ross Cory



D. A. MAC TAVISH, 1893-1959

Just before press time we heard the sad news that one of the AACC's long-time members, Mr. D. A. MacTavish, died at his home in Peterborough, Ontario on September 10. Mr. MacTavish was chief chemist with the Quaker Oats Co. more than 30 years, serving successively at Akron, Ohio and Cedar Rapids, Iowa before going to Canada in 1927.

Mr. MacTavish had suffered a heart attack several years ago, but was considered sufficiently recovered to lead a fairly active life up through his retirement, following which he settled down on his country residence near Peterborough. His death, reportedly sudden, resulted from a cerebral hemorrhage.

During his long career, Mr. MacTavish distinguished himself and his profession in a number of organizations. Considered an authority on flour and bakery problems, he traveled widely in later years, particularly to South America and to the West Indies.

Mr. MacTavish had been a member of the AACC since 1922. He was extremely active in the affairs of the Association and served on numerous committees. Among his assignments were the Membership Committee (Chairman), Local Section Chairman (Toronto Section), and Local Arrangements Chairman of the AACC's Niagara Falls meeting in 1946.

Mr. MacTavish is survived by his wife, Gladys, a son, Donald, and a daughter in Western Canada.

AUTUMN LEAVES

With the first chilly nights and yellowing leaves, fall begins in earnest. Thoughts turn from the cabin on the lake to ducks and pheasants and perhaps evening classes. It's always a good time of year to accomplish a few of the jobs we've put off during the summer months, even better than the day traditionally set aside for New Year's resolutions.

Your Executive Secretary hopes that all AACC members had a pleasant summer, particularly local section secretaries. I would like to remind all section secretaries that reports of section activities should be sent in to the St. Paul office whenever a local event warrants and certainly no less than once for each scheduled meeting. Report forms will be sent out to each section in the next week or ten days. Please use them so we can keep the rest of the AACC informed of your activities.

This is also an excellent time of year to recruit new members. I am sure that most of the sections could increase their number of national members by at least 10% if a real effort was made. Appoint your membership committee now and really get moving, before that last leaf falls!

R.J.T.

"Chicago in '60"

AACC's

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